ORTHOBOOK #1

VARIABILITY & HEALTH

INTRODUCTION TO HEART RATE VARIABILITY

OrthoBook
Health, Nutrition & Sport

AMIN GASMI

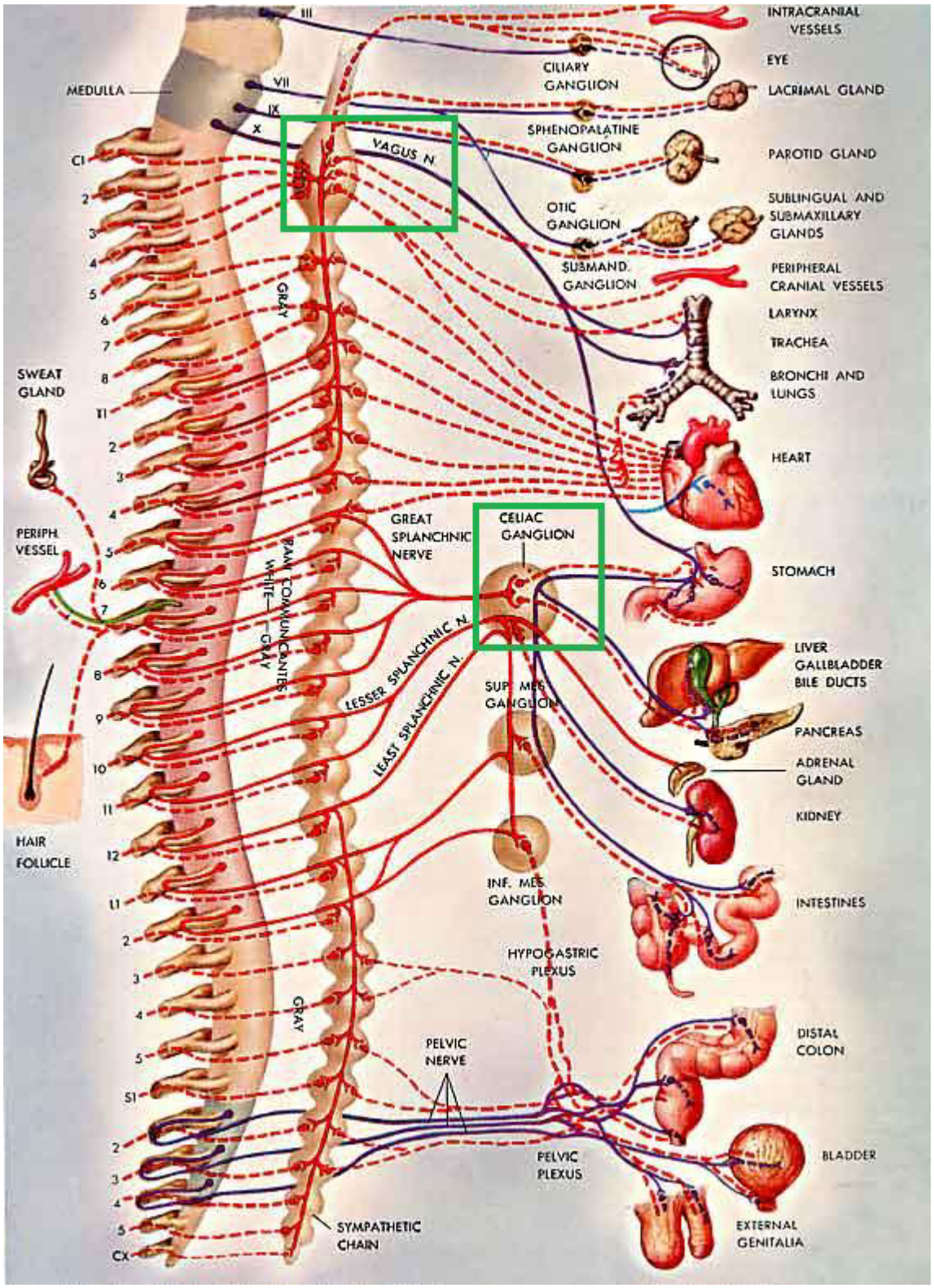
#1

Introduction to the autonomic nervous system:

The autonomic nervous system is the system that manages the vegetative life in humans and primates. It ensures the proper functioning of internal organs, their timing, the acceleration or deceleration of the general metabolism as required by the needs of our physiology in response to environmental changes. It is the discrete part of the central nervous system. Anatomically, the autonomic nervous system has its own central and peripheral structure, although it is part of the central nervous system.

The autonomic nervous system is synchronized to all systems that operate automatically and more or less outside the management of the central nervous system. It is formed by the interaction of two components: the sympathetic component also called orthosympathetic and the parasympathetic component. These two components have opposite but complementary functions. The sympathetic system is responsible of the excitation process, increases energy levels, and generally increases the most biological markers. The parasympathetic system has an antagonist action that promotes relaxation and activation of physiological recovery process.

The autonomic nervous system is the structure that modulates the overall health state, physical and mental performance as well as the mobilization of endocrine, immune and metabolic systems against any psychological or physiological imbalance or pathology. It is also the physiological matrix of what is called in psychology the unconscious mind. It is the physiological system hidden within the central nervous system that ensures the generation and development of more than 92% of your behavior. The exploration of the autonomic nervous system can explain the real causes of the imbalances, diseases, and lack of productivity and performance. In this presentation, we will discover one of the ways that will allow you to effectively explore this very powerful system and understand his functioning.



The science of variability:

Variability is a universal mathematical law largely unknown today, which can give a decisive contribution in the fields of health, sports, arts, and all areas of the help relationship. Giving an exact definition to variability would be very pretentious. However, we can explain the impact of this law on many situations. Let's start with an example from everyday's life (we will go to biological examples in a second time):

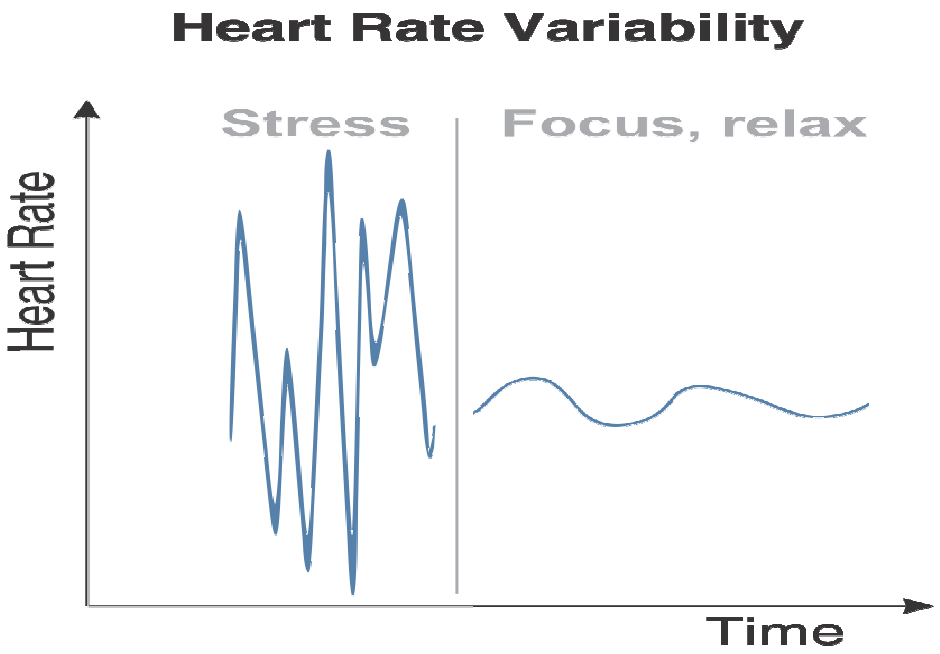
Imagine two planes, one led by a human pilot and the other works by an automatic guidance system. Now, suppose that these two planes fly together in the same way from point A to point B. The journey between point A and point B will be repeated several times. Now, let's compare the trajectory of gravity center of each plane during the trips they made successively. This is to compare the changes of a physical value (the linear path of the center of gravity) for the same plane. In the case of the plane which is led by a human, the linear trajectories of the aircraft's center of gravity will never be superimposed (never be exactly the same), there will always be a difference. In the case of an aircraft driven by an autopilot, the path will be the same regardless of the number of times that the operation will be repeated (of course by assuming that the external and internal stresses are inexistent).

The variations of trajectory on the first plane is due to intrinsic variability of living, zhich means that, the plane piloted by a human will always present changes in its trajectory, velocity, acceleration, and all cinematic features that could have an object in movement. This is what is called the intrinsic variability in the system or intraindividual variability. In the second plane, variability is zero because; it is not controlled by a living being.

Variability is a law that differentiates the living from the nonliving, but this is not the application that will interest us. We will use this law to explore the origin of our physiology, the autonomic nervous system.

There is a very useful application of this law in biological systems. Believe me, you have no idea on how variability might influence your life and the life of your entire environment (family, friends, clients, patients, athletes...etc.). Heart rate variability is one of the most remarkable applications of the science of variability in biological rhythmic systems. There are

several cardiac parameters in which we can use variability, but among these parameters we have one that is very useful, which is heart rate.



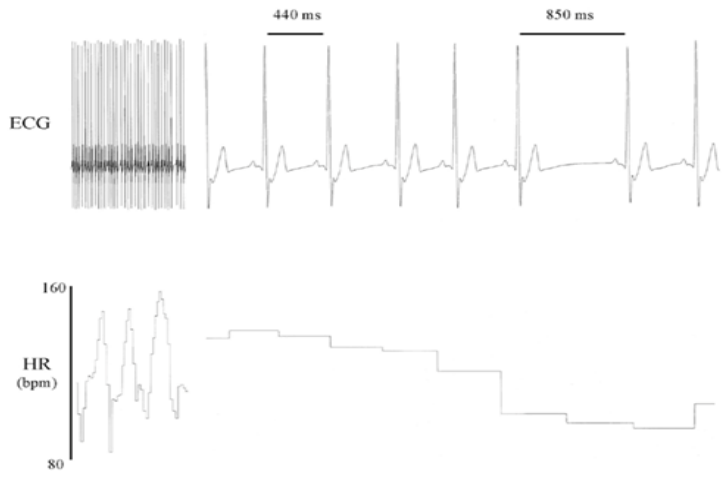
Heart rate variability is a parameter that has been explored by scientists in various fields, psychiatry, sports training, nephrology, cardiology, pathophysiology, pediatrics ... etc. Today we have over 500 scientific studies published in international journals about the heart rate variability. The efficiency of this parameter in determining the overall health, as a predicator of several metabolic disorders, overtraining or a mean of prevention, is now well established.

Heart rate variability, for its simple and affordable measures for everyone, will become in the coming decades, the marker number "one" in controlling health and physical and mental performance. This marker allows, by complex mathematical calculations automated in simple software, to understand the state of autonomic nervous system and its reaction to external (food, medication, trauma, pollution... etc.) and internal constraints (pathology, psychological stress, oxidative stress...etc.). What I just described is only a part of the benefits which can the analysis of heart rate variability give to health and clinical research. It can also predict diseases, or severe disorders months or even years before they occur.

Heart rate variability is measured by calculating the time intervals between two RR waves in a ECG graph QRS complex (intervals between heart beats). The amount of variation of an RR interval to another constitutes heart rate variability. This variation is mainly due to the activity of the autonomic nervous system.

Heart Rate Variability:

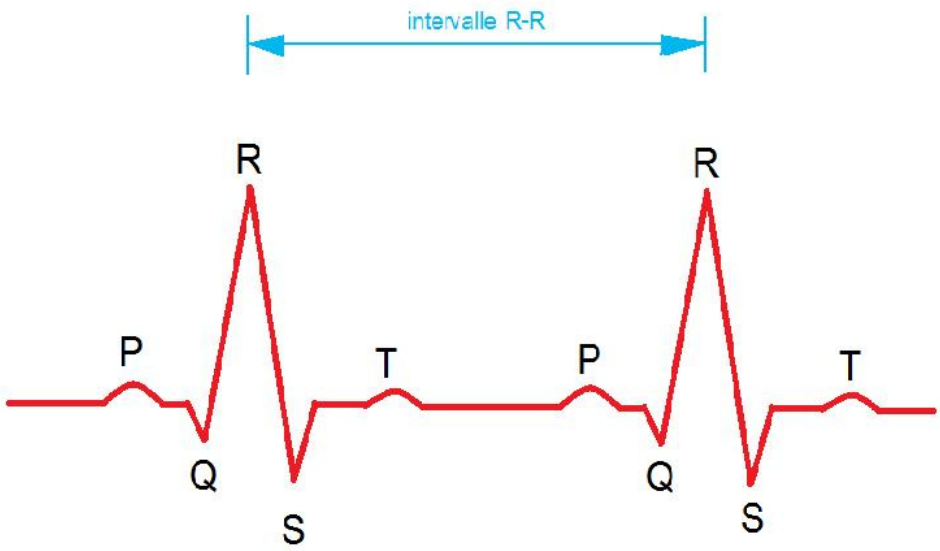
Heart rate variability is the quantity of variation in the periods of time between successive heart beats. Time intervals in an ECG graph are determined by measuring the distance between the RR waves of the QRS complex. It mainly depends on an intrinsic control of the heart rate. This marker is used to determine the heart's ability to adapt to changing circumstances by detecting and responding quickly to unpredictable stimuli. Analysis of this type of variability allows determining the state of the autonomic nervous system which responsible of the regulation of cardiac activity. Heart rate variability is very useful for understanding autonomic nervous system's state. It refers to variations of beat intervals during the instantaneous heart rate. Normal heart rate variability is due to the autonomic nervous regulation of the heart and blood flow. The balance between the sympathetic and parasympathetic nervous system controls the heart rate.



Increasing the activity of sympathetic nervous system or decreasing the activity of parasympathetic nervous system is the result of heart acceleration. Conversely, a decrease

in activity of sympathetic nervous system causes heart deceleration. The degree of variability in heart rate provides valuable information about the functioning of the autonomic nervous system and its overall effect on the body.

The autonomic nervous system is composed from sympathetic and parasympathetic components. Stimulation of sympathetic branch in response to stress, exercise, or any other type of activity causes an increase in heart rate by increasing the activity of sinoatrial node cells (cardiac rhythm generator).



Parasympathetic activity resulting mainly from operation of internal organs, trauma, allergic reactions or inhalation of certain substances decreases the activity of cells of sinoatrial node and therefore, we can also observe a decrease in heart rate. The contribution of both sympathetic and parasympathetic components modulates intervals between successive heartbeats. The analysis is performed by various means (affordable to all) they are analyzes in the time or spectral domain. We will in this document explain both types of analysis, but first, let me give you an idea about the potential applications of this unique marker.

Applications of heart rate variability:

If you are therapist, doctor, naturopath, health practitioners, biologist, clinician, nutritionist, athlete, coach, patient suffering from any chronic disease, or if you are just interested in your health, and the impact of environment on your body, then heart rate variability is the marker you need to definitely change your professional and / or personal approach relating to health. Let me give you some examples:

- In nutrition, you can test the impact of foods, dietary supplements, or any diet on the state of your autonomic nervous system and hence, on your general health state.
- In medicine, we can predict dozens of pathologies (with supporting evidence, by published studies and meta-analyzes) days, months or years in advance. Among these diseases: hypertension, myocardial infarction, cardiovascular diseases and neurodegenerative diseases, cardiac arrhythmias, renal failure, respiratory diseases, psychoses, neuroses ... etc. One can also observe the effect of a drug, substance or pollutant directly on the activity of autonomic nervous system and therefore on the general health.
- In alternative and complementary medicine, you can test the impact or effectiveness of methods, techniques, or any therapeutic procedure on the general state of health.
- In psychiatry and all branches that are related to applied and clinical psychology, you can detect and prevent psychological disorders before they appear in clinical signs or syndromes. You can also check the impact of the methods and techniques you apply, and quantify the progress of your results on a concrete and regular basis which refers to the activity of autonomic nervous system and patient's overall health.
- If you are sportsmen or sports coach, then, heart rate variability is used today by exercise physiologists in order to quantify the effect of your training program on the general metabolism of your body. You can adjust your training program according to heart rate variability data in order to keep your athletes fit and avoid overtraining.
- If you are someone who is passionate about physiology, nutrition, and preserving your health, so, this indicator gives you the opportunity to answer your questions specifically and individually. You can test your tolerance to foods, medicines,

nutritional supplements; know your adapted sleep time and the most suitable recovery and regenerating methods for your physiology. You can also observe the impact of a cure, a food mode, your daily activity, stress, and a many other parameters that you want to control. You can assess and quantify their relative effects on your health and your metabolism directly by soliciting your autonomic nervous system.

- If you suffer from any disease you can monitor your condition through heart rate variability, day after day, quantify and identify actions that allow you to feel better, not on a subjective basis or because you've read something about this, but by testing all those information by yourself using an objective and concrete parameter that directly questions your autonomic nervous system.
- There are other applications such as impact of drugs, tobacco, alcohol, and toxic substances on the functioning of autonomic nervous system and general health.
- Metabolic dysfunctions such as diabetes are at the heart of scientific research today. Protocols are implemented in exploring across heart rate variability, among other things, the behavior of autonomic nervous system in the generation of secondary disorders in diabetes.

These are just few practical uses resulting from the application of variability on one cardiac parameter which is heart rate. It is also possible to explore the impact of your living or working environment on your health and predict the type of disease that can occur if you stay in such environment. You can choose the environment or the most appropriate circumstances that allow your body to be in better health.

Methods of measurement and calculation of heart rate variability:

There are dozens of methods of calculation of the variability of heart rate but generally we could summarize them in two main categories:

- Linear methods: methods which correspond to temporal analysis, spectral analysis, or combined frequency-time analysis.

- Non-linear methods: autocorrelations, Poincare plots, analysis of fractals, the approximate and sampled entropy... etc.

We will not here make an applied mathematics course (which would not be accessible to everyone) but summarizing the most used methods in the study of heart rate variability. Most of these methods are integrated in software that you can easily use if you have basic training in interpretation of heart rate variability. Also you have to know that there are only less than 1% of scientific physiologists who know how to handle with these methods of complex calculation. In the training I provide on the measurement and interpretation of the heart rate variability, I developed working approach and simple teaching adapted and affordable for everyone (which is a first training of variability exploring in the whole world).

Interpreting heart rate variability data:

The simplest methods of calculation and analyzes are time and spectral domain. Analysis of Poincare plots also appears as the most affordable non-linear method and the most interesting in term of results.

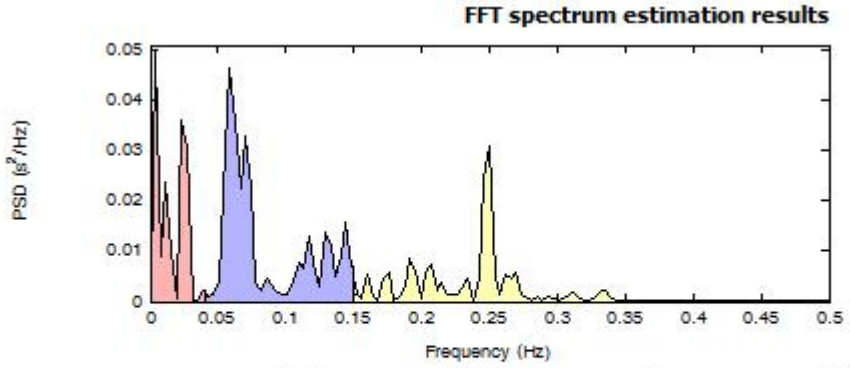
Time domain analysis:

We use indicators such SDNN, RMSSD or the coefficient of variation to give an overall figure and a rough estimate of the overall variability. These indicators can be used to estimate the amount of variability of a parameter (in this case, heart rate). A simple interpretation of those parameters is that heart rate variability increases when the health state of the individual goes better. If this parameters decrease it means that health state is being deteriorated. We could, by using several measures of heart rate variability performed in well-chosen circumstances, make comparisons between different indicators and conclude that such practice, method, food, drug, circumstance, has a deleterious, neutral, or beneficial effect on health.

It has been proved by hundreds of scientific publications that increased variability would be reliable indicator of good health. The analysis in the time domain with the SDNN or RMSSD and other lesser-known statistical indicators can give an overall score of health state in every individual, directly questioning the physiological system that lead all physiological processes: the autonomic nervous system. However, this analysis has a major disadvantage because it does not differentiate between sympathetic and parasympathetic activity.

Spectral domain analysis:

This method of analysis is based primarily on the fast Fourier transform (a mathematical calculation method). The advantage of this method is to distinguish the different waves in frequency intervals. Researches performed till now distinguish four types of frequencies:



Frequency Band	Peak (Hz)	Power (ms^2)	Power (%)	Power (n.u.)
VLF	0.0039	632	25.0	
LF	0.0586	1234	48.8	65.0
HF	0.2500	665	26.3	35.0
LF/HF			1.9	

- Ultra-low frequencies whose origin is unknown

- Very low frequencies that are not well known today, but more and more researches show that the temperature control process is the origin of these frequencies.

- Low frequencies: which the origin is sympathetic nervous system activity (with still a small part due to baroreflex)

- High frequencies: which the origin is the parasympathetic nervous system activity. They are strongly influenced by respiration (we can therefore understand the close connection between breathing, parasympathetic nervous system, and heart rate).

What interests us in the spectral analysis method are the low and high frequency spectra that correspond to the activity of the sympathetic and parasympathetic nervous system. There is relatively simple use software that can give a graphical view of these two types of spectra.

Why the science of variability is not known and used?

1- Because we are at the beginning! 500 studies on vast domain such as heart rate variability is nothing! There are still many other fields to explore.

2- The knowledge of the science of variability is owned today by a minority of scientists. Even among scientists the majority are not informed about it. I remember dozens of them asking me questions about what is variability and at the end being amazed when they understood the issues behind the science of variability.

3- Studying variability is very complex task even for scientists who must gather in multidisciplinary teams to work on the variability of a phenomenon. Nobody has the idea to popularize variability and make it affordable to all. In the training I provide you will find a simple and easy teaching, presenting the simplest means by which you can measure and interpret heart rate variability without having to perform complex and very difficult calculations (actually you will have no calculation to do). This is a simple protocol, structured in stages, step by step that anyone (even without any knowledge about variability) could achieve. You will find everything you need for using heart rate variability optimally.

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